SHELL MODEL TREATMENT OF NEUTRON-RICH NUCLEI NEAR ^{78}Ni

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Neutron-rich nickel isotopes in the vicinity of $^{78}_{28}$Ni$_{50}$ are currently in the focus of modern nuclear physics and astrophysics studies. The interest in this region is motivated by the doubly magic nature of $^{78}_{28}$Ni and understanding the way in which the neutron excess will affect the properties of nearby nuclei. The shell-model orbitals for neutrons in nuclei with $Z = 28$ and N=28-50 (^{56}Ni-^{78}Ni) are the same as those for protons in nuclei with N=50 and Z=28-50 (^{78}Ni-^{100}Sn). Thus it is of interest to understand the similarities and differences in the properties of these nuclei with valence-mirror symmetry. The astrophysical importance is related to the understanding of the nuclear mechanism of the rapid capture of neutrons by seed nuclei through the r-process. The path of this reaction network is expected in neutron-rich nuclei for which there is little experimental data, and the precise trajectory is dictated by the details of the shell structure far from stability.

This contribution reports on results obtained with new effective interactions for the $pf_{5/2}g_{9/2}$ model space derived from a fit to experimental data for Ni isotopes from $A = 57$ to $A = 78$ and $N = 50$ isotones from ^{79}Cu to ^{100}Sn for neutrons and protons, respectively. Predictions for the $^{72-76}$Ni isotopes are made using the new effective interaction. The calculated structures of the ^{68,70,72,74,76}Ni isotopes and the ^{90}Zr, ^{92}Mo, ^{94}Ru, ^{96}Pd, ^{98}Cd are compared and analyzed with respect to the valence mirror symmetry concept. Our work provides a much improved Hamiltonian for $Z = 28$ over those considered in smaller model spaces and a new Hamiltonian for $N = 50$ that is similar to those obtained previously.

Full configuration mixing calculations for neutrons or protons in this model space are relatively easy. The work we describe here on the $T = 1$ effective interactions will provide a part of the input for the larger model space of both protons and neutrons in these orbits. This proton-neutron model space is computationaly feasible with conventional matrix-diagonalization techinques for many nuclei in the mass region A=56-100, and Monte-Carlo techniques can be used for all nuclei.